

Several other advantages would appear to be attainable in accordance with at least one presently preferred embodiment of the present invention. For example, an entire protocol can be stored and recalled for future use. The injector can reserve the flushing medium that is needed for an entire protocol and can alert the operator, before an injection commences, as to insufficient fluid volume. Moreover, in a multi-phased protocol that includes flushing and has an intermediate "hold" phase, the protocol can shut off flow in a "KVO" state automatically in order to preserve any necessary flushing medium for a subsequent pre-programmed flushing phase.

Although a maximum of six phases for one protocol has been described hereabove, it will be appreciated that the present invention broadly contemplates that no maximum on the number of phases in a protocol necessarily need be imposed.

Although all types of phases, especially contrast medium and flushing medium phases, have essentially been described hereinabove as being linear in nature (i.e., having a fixed flowrate over the duration of the phase), it should be understood that the present invention also broadly contemplates the programming and execution of phases that are not linear in nature. For example, it is conceivable that a contrast medium or flushing medium phase (and possibly even a "KVO" phase) could represent a non-linear function, in which the flowrate could possibly be variable over the duration of the phase and could be programmed in by means of an equation, lookup table or other suitable arrangement. In the case of "KVO", it is even conceivable that short "bursts" of flushing medium could be emitted at a variable rate instead of a fixed rate.

Although syringes have been specifically contemplated hereinabove for use in injection protocols, as a means for storing and administering contrasting medium or flushing medium, it is to be understood that other arrangements for this purpose are conceivable within the scope of the present invention, such as, for example, the use of peristaltic pumps.

In the context of the present disclosure, the terms "infusion" and "injection", and their grammatical derivations, are to be construed as being interchangeable and are meant to refer to essentially any of a wide range of arrangements for introducing fluid into a patient.

If not otherwise stated herein, it may be assumed that all components and/or processes described heretofore may, if appropriate, be considered to be interchangeable with similar components and/or processes disclosed elsewhere in the specification, unless an express indication is made to the contrary.

If not otherwise stated herein, any and all patents, patent publications, articles and other printed publications discussed or mentioned herein are hereby incorporated by reference as if set forth in their entirety herein.

It should be appreciated that the apparatus and method of the present invention may be configured and conducted as appropriate for any context at hand. The embodiments described above are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is defined by the following claims rather than the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container

containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, the control device operable to selectively program a plurality of phases of an injection procedure, each of the plurality of phases comprising at least one of a contrast medium phase, a flushing medium phase and a KVO phase.

2. The apparatus of claim 1 wherein at least one of the two fluid containers comprises a syringe.

3. The apparatus of claim 1 wherein the first phase comprises a flushing medium phase and the second phase comprises a contrast medium phase.

4. The apparatus of claim 1 wherein the phases are defined by at least two injection parameters selected from fluid flow rate, fluid volume and injection duration.

5. A fluid injection apparatus comprising:

at least one drive mechanism;

at least one fluid container operably associated with the at least one drive mechanism; and

a control device operably associated with the at least one drive mechanism, the control device operable to selectively program at least two phases of an injection procedure, the first phase comprising one of at least a contrast medium phase and a flushing medium phase and the second phase comprising a hold phase, wherein KVO occurs during the hold phase.

6. The apparatus of claim 5 wherein the hold phase is of indefinite duration.

7. The apparatus of claim 5 wherein the hold phase allows an operator to modify one or more injection parameters of a subsequent phase.

8. The apparatus of claim 5 wherein the at least one fluid container comprises a syringe.

9. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising: means for programming a first phase of an injection procedure;

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure; and

means for programming a third phase of an injection procedure, subsequent to a second phase of an injection procedure, as a phase other than a flushing medium phase.

10. The apparatus of claim 9, wherein said means for programming a first phase of an injection procedure comprises means for programming a first phase of an injection procedure as a phase other than a contrast medium phase.

11. The apparatus of claim 10, wherein said means for programming a first phase of an injection procedure comprises means for programming a first phase of an injection procedure as a contrast medium phase.

12. The apparatus of claim 9, wherein said means for programming a second phase of an injection procedure comprises:

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a contrast medium phase; and

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a flushing medium phase.

11

13. The apparatus of claim 9, wherein said control device further comprises means for programming a third phase of an injection procedure as a flushing medium phase.

14. The apparatus of claim 9, wherein said means for programming a second phase of an injection procedure comprises means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a hold phase.

15. The apparatus of claim 9, wherein said control device further comprises means for programming a pause phase to occur between first and second phases of an injection procedure.

16. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising: means for programming a first phase of an injection procedure;

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure;

means for programming a third phase of an injection procedure, subsequent to a second phase of an injection procedure; and

means for programming a fourth phase of an injection procedure, subsequent to a second phase of an injection procedure, as a phase other than a flushing medium phase.

17. The apparatus of claim 16, wherein said means for programming a first phase of an injection procedure comprises means for programming a first phase of an injection procedure as a phase other than a contrast medium phase.

18. The apparatus of claim 17, wherein said means for programming a first phase of an injection procedure comprises means for programming a first phase of an injection procedure as a contrast medium phase.

19. The apparatus of claim 16, wherein said means for programming a second phase of an injection procedure comprises:

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a flushing medium phase; and

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection, as a flushing medium phase.

20. The apparatus of claim 16, wherein said means for programming a third phase of an injection procedure comprises:

means for programming a third phase of an injection procedure, subsequent to a second phase of an injection procedure, as a contrast medium phase; and

means for programming a third phase of an injection procedure, subsequent to a second phase of an injection procedure, as a flushing medium phase.

21. The apparatus of claim 16, wherein said control device further comprises means for programming a fourth phase of an injection procedure, subsequent to a third phase of an injection procedure, as a flushing medium phase.

22. The apparatus of claim 16, further comprising means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a hold phase.

12

23. The apparatus of claim 16, wherein said control device further comprises:

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure; and

means for programming a pause phase to occur between first and second phases of an injection procedure.

24. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising means for programming a first phase of an injection procedure as a phase other than a contrast medium phase.

25. The apparatus of claim 24, wherein said control device further comprises means for programming a first phase of an injection procedure as a contrast medium phase.

26. The apparatus of claim 24 wherein at least one of the two fluid containers comprises a syringe.

27. The apparatus of claim 24 wherein said means for programming a first phase of an injection procedure as a phase other than a contrast medium phase comprises means for programming a first phase of an injection procedure as a flushing medium phase.

28. The apparatus of claim 24, wherein said control device further comprises means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a contrast medium phase.

29. The apparatus of claim 24, wherein said control device further comprises means for defining at least one phase of an injection procedure by at least two injection parameters selected from fluid flow rate, fluid volume and injection duration.

30. The apparatus of claim 24, wherein said control device further comprises means for defining each phase of an injection procedure by at least two injection parameters selected from fluid flow rate, fluid volume and injection duration.

31. The apparatus of claim 24 wherein said control device further comprises:

means for programming a first phase of an injection procedure as a KVO phase.

32. The apparatus of claim 24 wherein said control device further comprises means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a flushing medium phase.

33. The apparatus of claim 24 wherein said control device further comprises means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a KVO phase.

34. The apparatus of claim 24, further comprising means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a hold phase.

35. The apparatus of claim 34 wherein said means for programming a second phase of an injection procedure as a hold phase comprises means for establishing a hold phase of indefinite duration.

36. The apparatus of claim 35 wherein said means for programming a second phase of an injection procedure as a hold phase comprises means for establishing KVO during a hold phase.

13

37. The apparatus of claim 34, wherein said control device further comprises means for facilitating, during a hold phase, modification of one or more injection parameters of a subsequent phase.

38. The apparatus of claim 24, wherein said control device further comprises:

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure; and

means for programming a pause phase to occur between first and second phases of an injection procedure.

39. The apparatus of claim 38, wherein said means for programming a first phase of an injection procedure as a phase other than a contrast medium phase comprises means for programming a first phase of an injection procedure as a flushing medium phase.

40. The apparatus of claim 38, wherein said means for programming a second phase of an injection procedure comprises:

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a contrast medium phase; and

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a flushing medium phase.

41. The apparatus of claim 38 wherein said means for programming a pause phase comprises means for establishing a pause phase for a fixed duration of time.

42. The apparatus of claim 38 wherein said control device comprises means for automatically commencing a second phase of an injection procedure after the end of a pause phase.

43. A fluid injection apparatus comprising:

at least one drive mechanism;

at least one fluid container operably associated with the at least one drive mechanism; and

a control device operably associated with the at least one drive mechanism, said control device comprising:

means for programming a first phase of an injection procedure as a contrast medium phase;

means for programming a first phase of an injection procedure as a flushing medium phase; and

means for programming a second phase of an injection procedure, subsequent to a first phase of an injection procedure, as a hold phase.

44. A fluid injection apparatus comprising:

at least one drive mechanism;

at least one fluid container operably associated with the at least one drive mechanism; and

a control device operably associated with the at least one drive mechanism, said control device comprising:

means for programming a first phase of an injection procedure as a contrast medium phase;

means for programming a first phase of an injection procedure as a flushing medium phase;

means for programming a second phase of an injection procedure as a contrast medium phase;

means for programming a second phase of an injection procedure as a flushing medium phase; and

means for programming a pause phase to occur between first and second phases of an injection procedure.

45. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container

14

containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising means for establishing a first phase of an injection procedure as a phase other than a contrast medium phase.

46. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising an arrangement for programming a first phase of an injection procedure as a phase other than a contrast medium phase.

47. A fluid injection apparatus comprising:

at least one drive mechanism;

at least two fluid containers operably associated with the at least one drive mechanism, one fluid container containing a contrast medium and the other fluid container containing a flushing medium; and

a control device operably associated with the at least one drive mechanism, said control device comprising an arrangement for establishing a first phase of an injection procedure as a phase other than a contrast medium phase.

48. A method of programming an injection apparatus comprising a drive mechanism, at least two fluid containers and a control device for programming the injection procedure, the method comprising:

selectively programming a plurality of phases of an injection procedure, each of the plurality of phases comprising at least one of a contrast medium phase, a flushing medium phase and a KVO phase.

49. A method of programming an injection apparatus comprising a drive mechanism, at least two fluid containers and a control device for programming the injection procedure, the method comprising:

selectively programming at least two phases of an injection procedure, the first phase comprising one of at least a contrast medium phase and a flushing medium phase and the second phase comprising a hold phase, wherein KVO occurs during the hold phase.

50. A method of programming an injection procedure, comprising:

providing an injection apparatus comprising a drive mechanism, at least two fluid containers and a control device for programming the injection procedure;

selectively programming a first phase of the injection procedure, the first phase comprising one of a contrast medium phase and a flushing medium phase;

selectively programming at least a subsequent second phase of the injection procedure, the second phase comprising one of a contrast medium phase and a flushing medium phase; and

selectively programming a KVO phase.

51. A method of programming an injection procedure comprising:

programming a first phase of an injection procedure;

programming a second phase of an injection procedure to occur subsequent to the first phase; and

programming a third phase of an injection procedure, to occur subsequent to the second phase, as a phase other than a flushing medium phase.

52. The method of claim 51, wherein said step of programming a first phase of an injection procedure comprises selectably programming the first phase of an injection procedure as a phase other than a contrast medium phase.

53. The method of claim 52, wherein said step of programming a first phase comprises selectably programming the first phase as a contrast medium phase.

54. The method of claim 51, wherein said step of programming a second phase comprises selectably programming the second phase as a contrast medium phase.

55. The method of claim 51, wherein said step of programming a second phase comprises selectably programming the second phase as a flushing medium phase.

56. The method of claim 51, wherein:

said step of programming a third phase is performed during one protocol; and

said method further comprises, during another protocol, the step of selectably programming a third phase of an injection procedure as a flushing medium phase.

57. The method of claim 51, wherein said step of programming a second phase of an injection procedure comprises selectably programming the second phase as a hold phase.

58. The method of claim 51, further comprising the step of programming a pause phase to occur between first and second phases of an injection procedure.

59. A method of programming an injection procedure comprising:

programming a first phase of an injection procedure; programming a second phase of an injection procedure to occur subsequent to the first phase;

programming a third phase of an injection procedure to occur subsequent to the second phase; and

programming a fourth phase of an injection procedure, to occur subsequent to the third phase, as a phase other than a flushing medium phase.

60. The method of claim 59, wherein said step of programming a first phase of an injection procedure comprises selectably programming the first phase of an injection procedure as a phase other than a contrast medium phase.

61. The method of claim 59, wherein said step of programming a first phase comprises selectably programming the first phase as a contrast medium phase.

62. The method of claim 59, wherein said step of programming a second phase comprises selectably programming the second phase as a contrast medium phase.

63. The method of claim 59, wherein said step of programming a second phase comprises selectably programming the second phase as a flushing medium phase.

64. The method of claim 59, wherein said step of programming a third phase comprises selectably programming the third phase as a contrast medium phase.

65. The method of claim 59, wherein said step of programming a third phase comprises selectably programming the third phase as a flushing medium phase.

66. The method of claim 59, wherein:

said step of programming a fourth phase is performed during one protocol; and

said method further comprises, during another protocol, the step of selectably programming a fourth phase of an injection procedure as a flushing medium phase.

67. The method of claim 59, wherein said step of programming a second phase of an injection procedure comprises selectably programming the second phase as a hold phase.

68. The method of claim 59, further comprising the step of programming a pause phase to occur between first and second phases of an injection procedure.

69. A method of programming an injection procedure comprising: programming a first phase of an injection procedure as a phase other than a contrast medium phase.

70. The method of claim 69, wherein:

said step of programming a first phase is performed during one protocol; and

said method further comprises, during another protocol, the step of selectably programming a first phase of an injection procedure as a contrast medium phase.

71. The method of claim 69, further comprising the step of programming a KVO phase.

72. The method of claim 69, further comprising the step of programming a second phase of an injection procedure, to occur subsequent to a first phase of an injection procedure, as a hold phase.

73. The method of claim 69, further comprising the step of modifying, during said hold phase, one or more injection parameters of a subsequent phase.

74. The method of claim 69, further comprising:

programming a second phase of an injection procedure to occur subsequent to the first phase of an injection procedure; and

programming a pause phase to occur between first and second phases of an injection procedure.

75. The method of claim 74, wherein said step of programming a first phase comprises selectably programming the first phase as a flushing medium phase.

76. The method of claim 74, wherein said step of programming a second phase comprises selectably programming the second phase as a contrast medium phase.

77. The method of claim 74, wherein said step of programming a second phase comprises selectably programming the second phase as a flushing medium phase.

78. The method of claim 74 wherein said step of programming a pause phase comprises establishing said pause phase for a fixed duration of time.

79. A method of programming an injection procedure, comprising:

selectably programming a first phase of an injection procedure, during a first protocol, as a contrast medium phase;

selectably programming a first phase of an injection procedure, during a second protocol, as a flushing medium phase; and

programming a second phase of an injection procedure, subsequent to the first phase during at least one of said first and second protocols, as a hold phase.

80. A method of programming an injection procedure, comprising:

selectably programming a first phase of an injection procedure, during a first protocol, as a contrast medium phase; selectably programming a first phase of an injection procedure, during a second protocol, as a flushing medium phase;

selectably programming a second phase of an injection procedure, during one of said first and second protocols, as a contrast medium phase;

selectably programming a second phase of an injection procedure, during one of said first and second protocols, as a flushing medium phase; and

programming a pause phase to occur between first and second phases of an injection procedure, during at least one of said first and second protocols.